

Developments in Latent Fingerprint Technologies

Evaluation of Latent Fingerprint Technologies (ELFT) Project

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Rolled Fingerprint



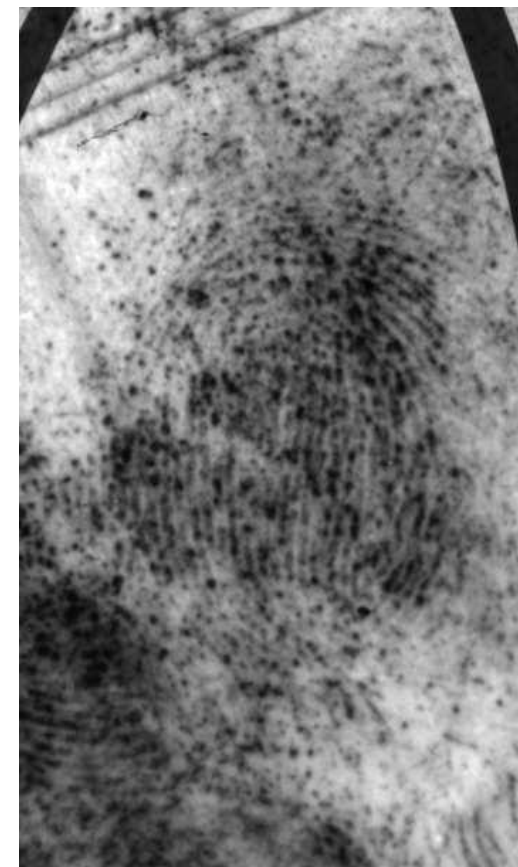
(ink capture)

Plain Fingerprint



(ink capture)

Latent Fingerprint

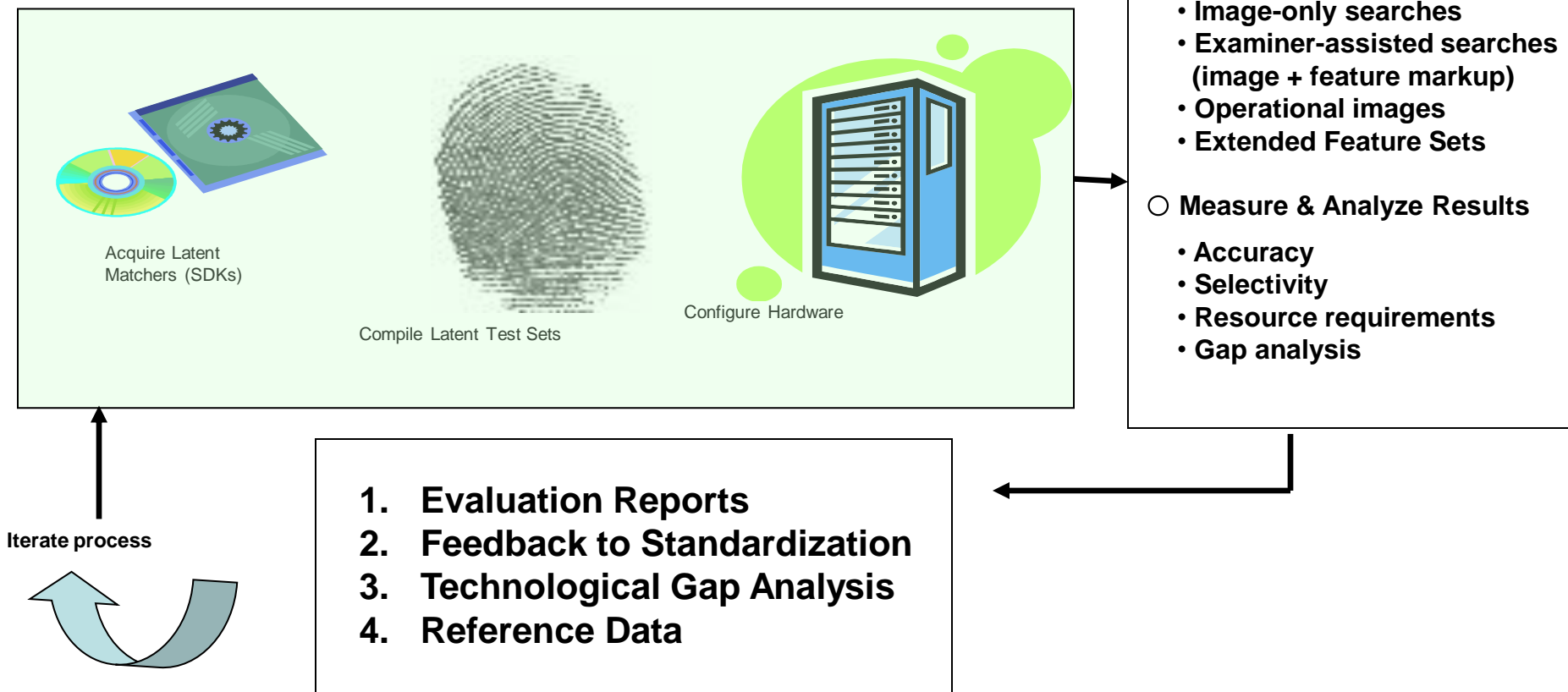


(powder lift)

ELFT Project Timeline

- 2006 NIST Latent Fingerprint Testing Workshop
- 2007 **ELFT Phase I Evaluation**
- 2008 **ELFT Phase II Evaluation**
- 2009 NIST Latent Fingerprint Testing Workshop
ELFT Phase II Miss Analysis Sessions
ELFT-EFS Public Challenge
- 2010 **ELFT-EFS Evaluation #1**
ELFT-EFS Miss Analysis Sessions
- 2011 **ELFT-EFS Evaluation #2**

NIST Evaluation of Latent Fingerprint Technologies (ELFT)



AFIS

Latent Examiner



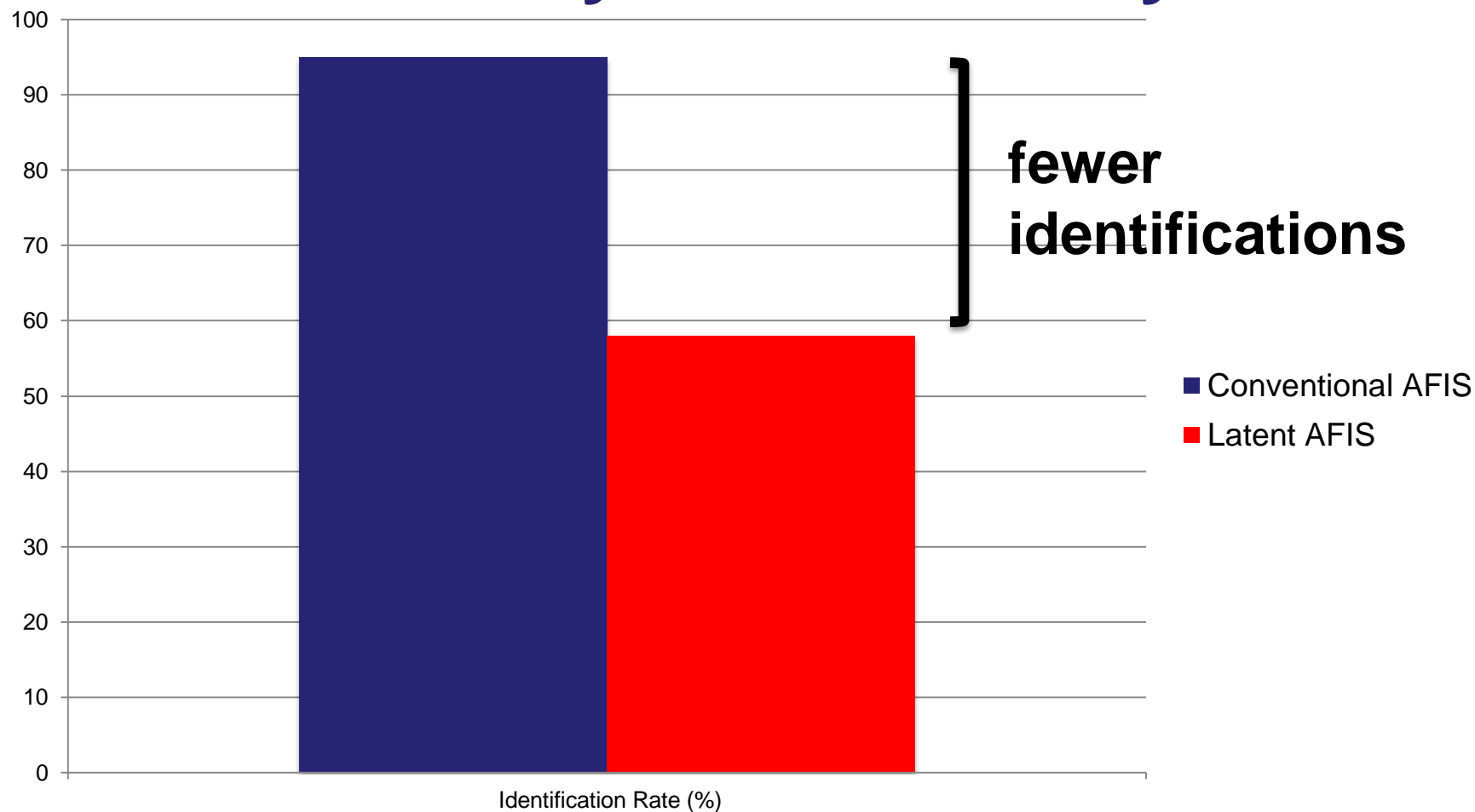
*Latent image
(+ features)
"Search"*



*Potential
matches*

Rank	Candidate
1	
2	
3	
...	
20	

Latent AFIS Technology Gaps: Relatively Low Accuracy



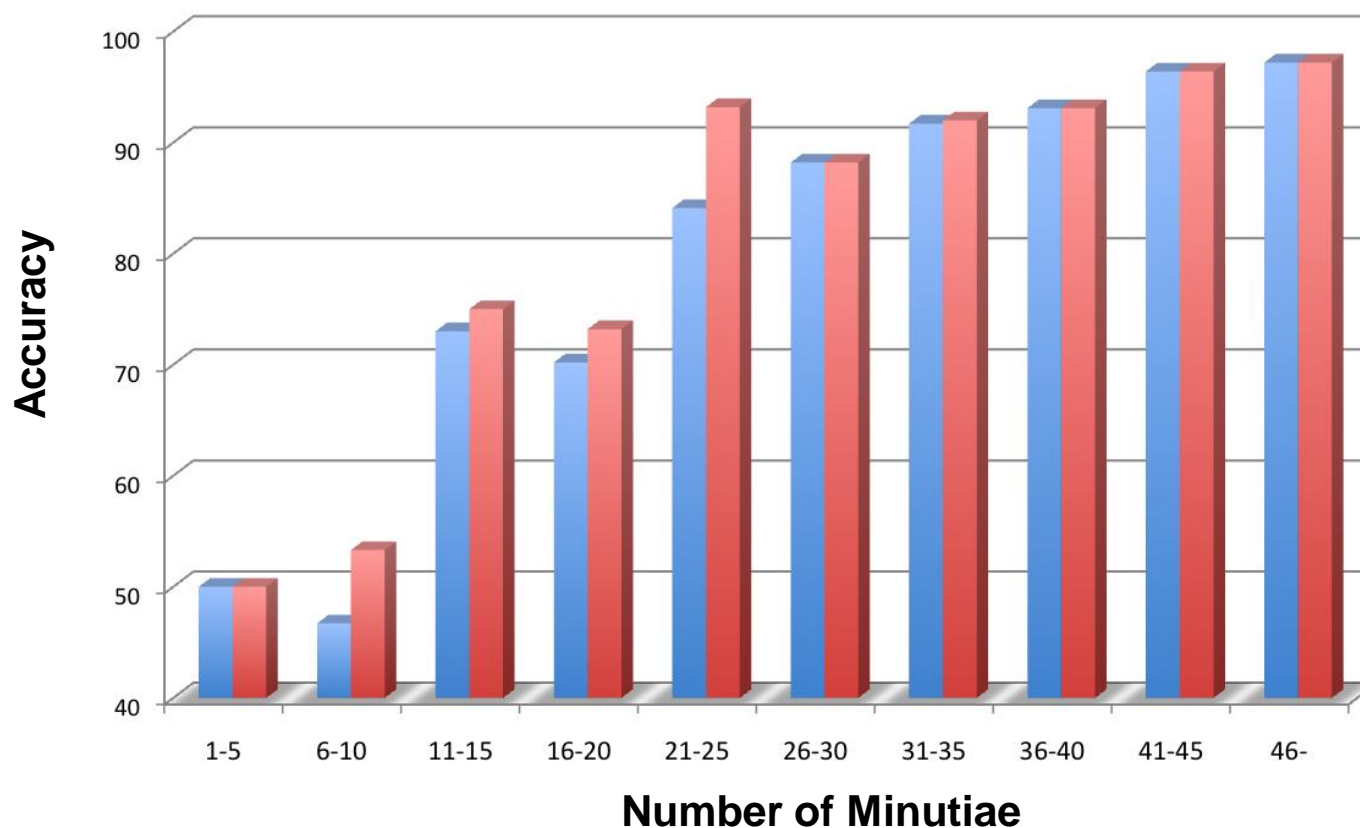
Latent AFIS Technology Gaps

- **Relatively low accuracy**
 - 65-70% identification rate considered “high performance”
- **High manual workload**
 - features selection & markup
 - candidate list evaluation

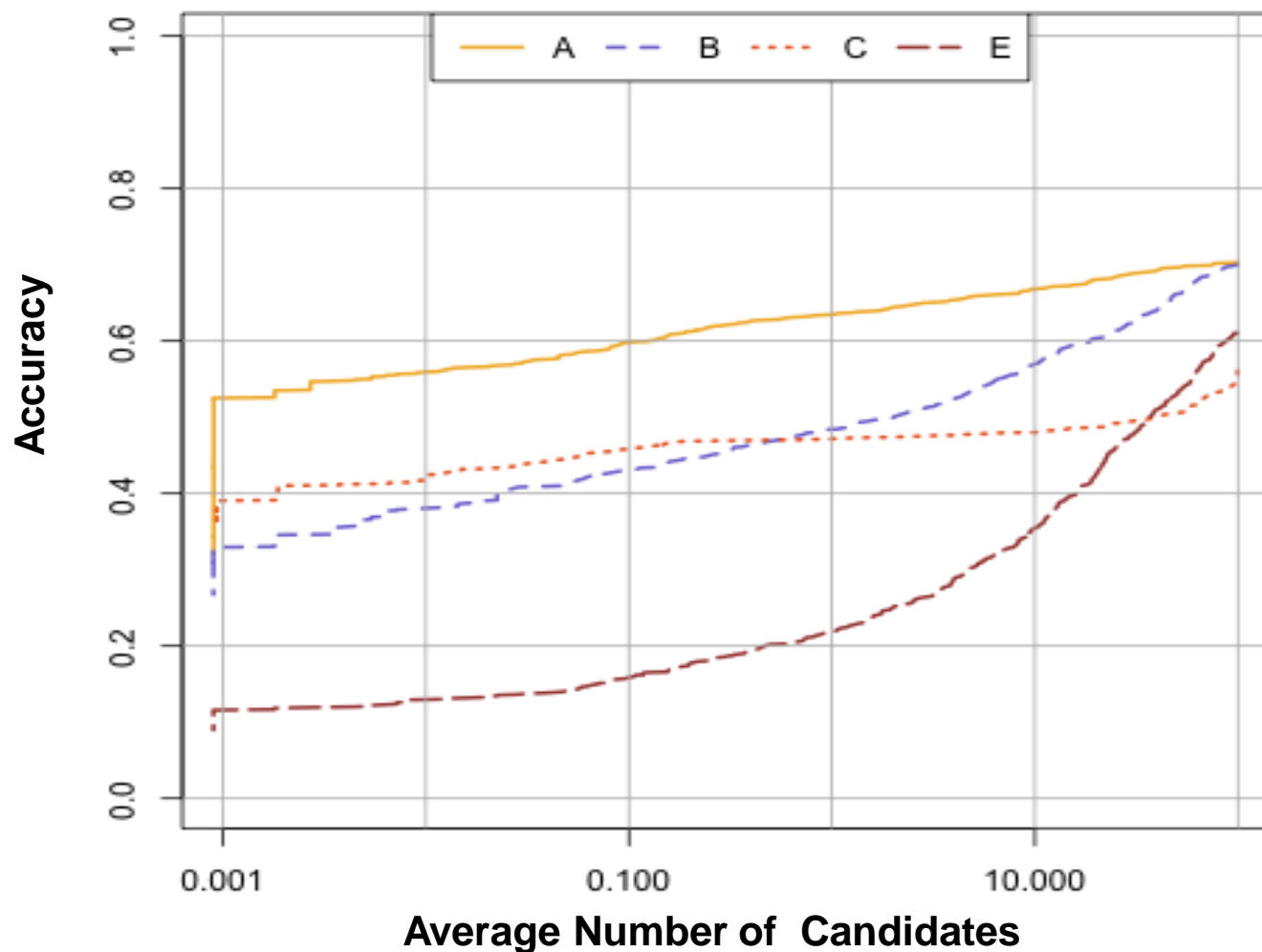
Solution: Measurement and evaluation of searches using image only (“lights out”) vs. manually assisted search performance, and evaluation of candidate list reduction methods.

ELFT Results: “Lights out” vs Manual Feature Selection

■ image only ■ image + features



ELFT Results: Accuracy vs. Examiner Workload



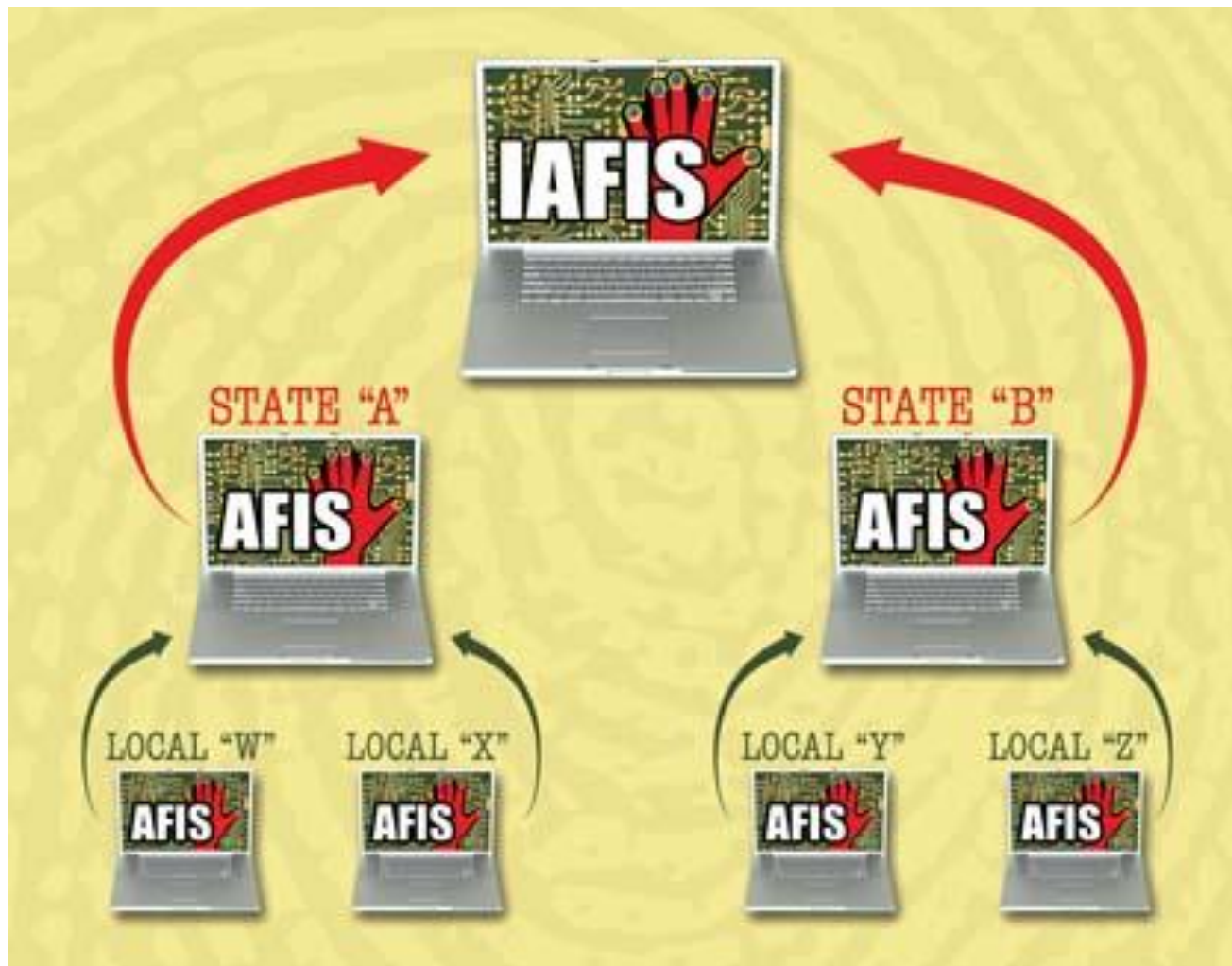
Latent AFIS Technology Gaps

➤ Limited interoperability

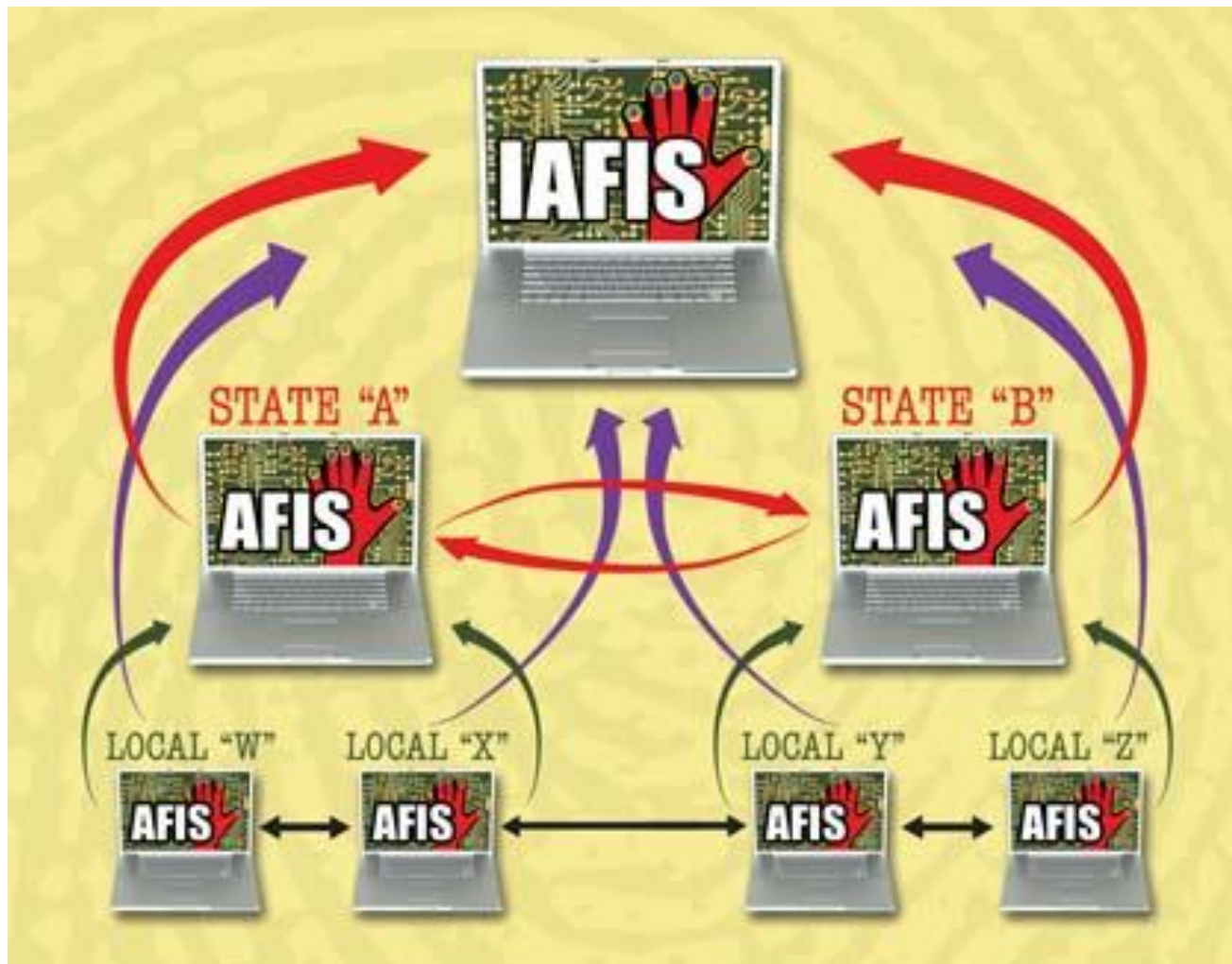
- best accuracy requires manual feature selection/markup
- commercial AFIS use non-standard features
- even the same features vary between AFIS
- no universal standard for feature selection/markup
- features re-selected/marked for each new AFIS searched

Solution: Develop a comprehensive set of features which can be used to build a universal set of latent fingerprint search transactions. Latent Interoperability Transmission Specification (LITS) based on ANSI/NIST-ITL 2011 which includes Extended Feature Sets (EFS) and FBI EBTS.

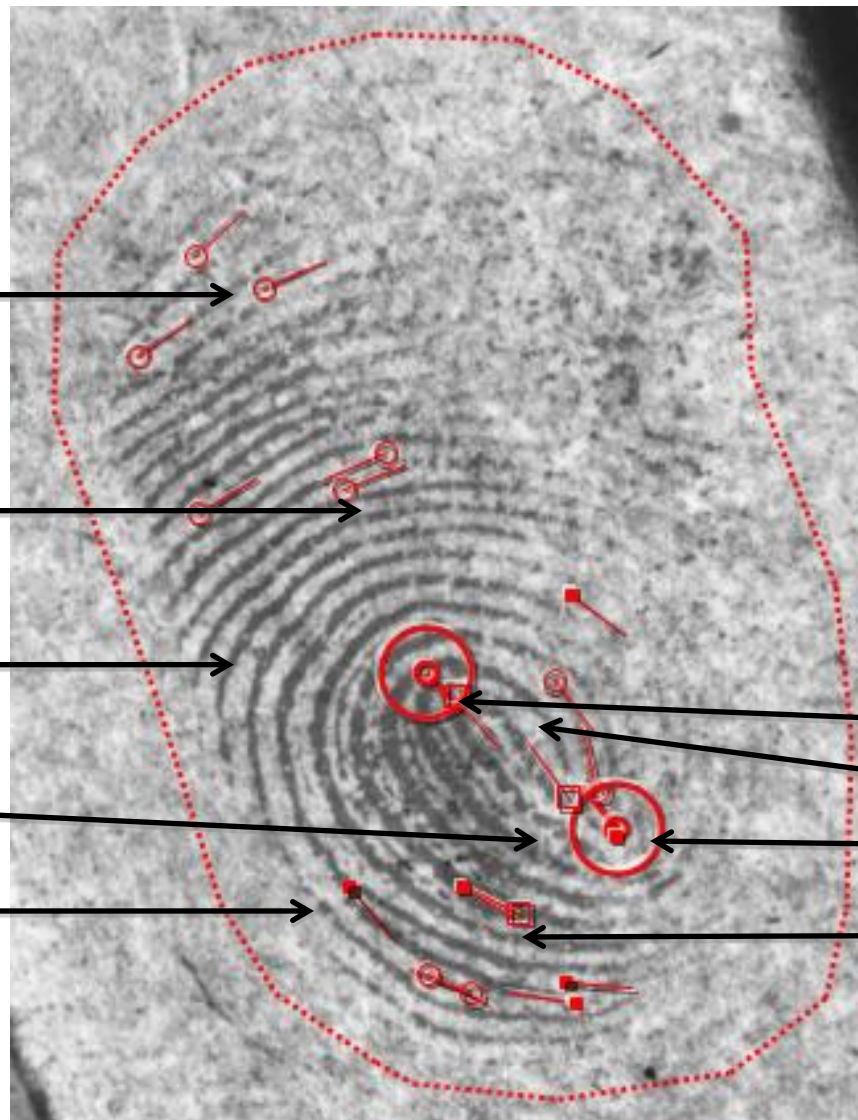
AFIS Interoperability: Now



AFIS Interoperability: Future



Extended Feature Set (EFS)



Ridge
ending

Incipient

Protrusion

Pore

Indeterminate

Core

Dot

Core

Bifurcation

Improved Feature Quality



○ *region quality map*

Improved Feature Set:

○ *endings/bifurcations*

○ *pores*

○ *protrusions*



○ *incipient ridges*

○ *dots*

○ *creases*

○ *scars*

○ *skeleton*

EFS Evaluation & Testing

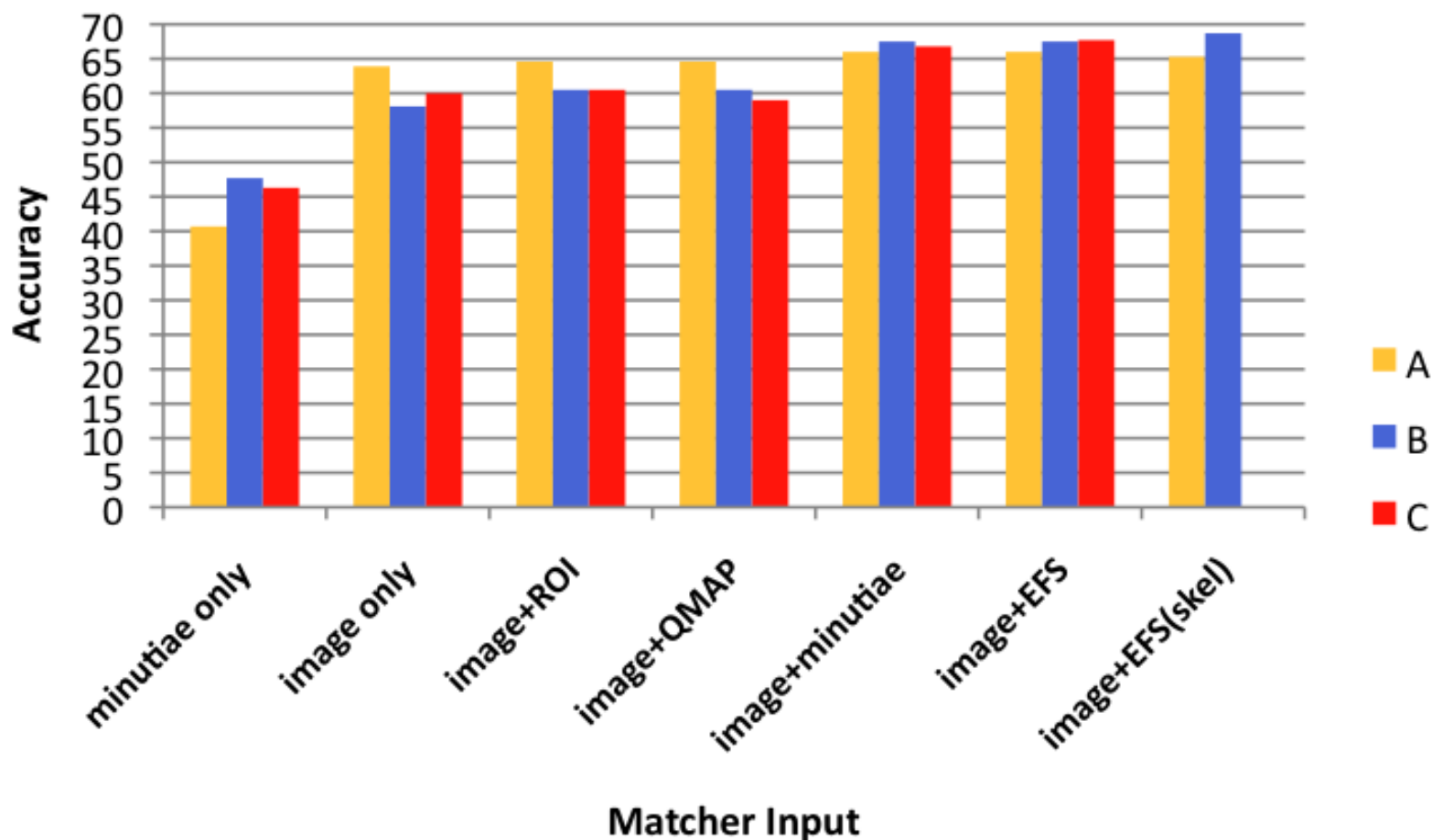
▪ ELFT-EFS Evaluation #1

- 1st Multi-vendor AFIS matcher evaluation using a common feature set (EFS)
- Features defined by upcoming ANSI/NIST-ITL 2011 standard
- Feature marked by experienced latent examiners using a common guidelines
- Assesses the performance of latent AFIS search technology with:
 - ✓ minutiae only
 - ✓ image only
 - ✓ image + *various subsets of EFS*
- Final Report: **NISTIR 7775**, March 2011

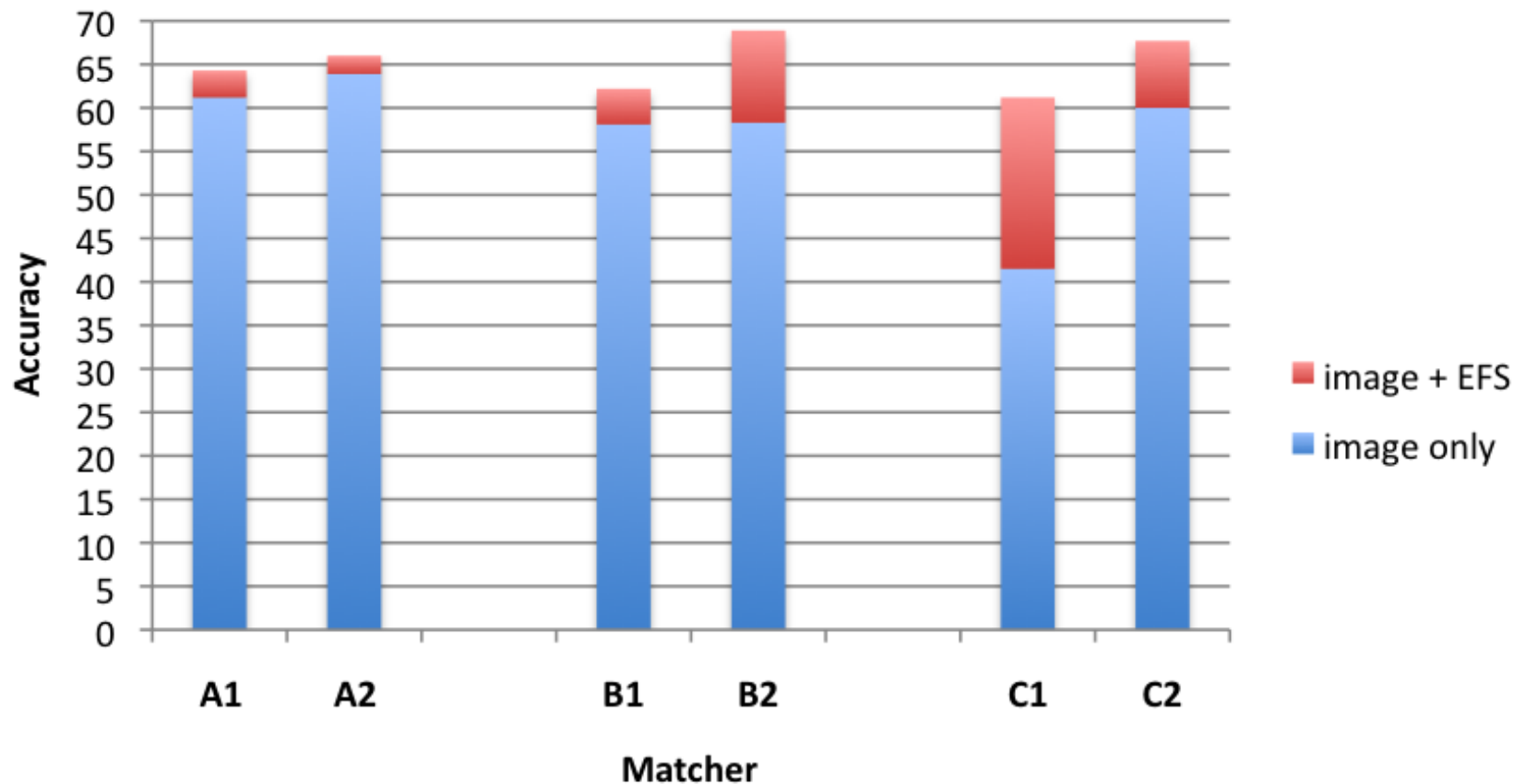
▪ ELFT-EFS Evaluation #2

- Re-iteration of Evaluation #1 with updated algorithms
- Follows miss analysis sessions conducted with developers
- Measures improvements/regressions in matcher performance
- Provides better estimate of state of the art
- Final Report TBD October 2011

ELFT-EFS Results: Accuracy vs. EFS Feature Subset



ELFT-EFS Results: Accuracy Improvement (Eval 1 vs. 2)



Future Work

- ELFT-LITS (*start date to be announced Fall 2011*)
 - LITS = Latent Interoperability Transmission Specification (LITS)
 - evaluation of LITS based search transaction performance
- ELFT-PALM (*start date to be announced Fall 2011*)
 - evaluation of AFIS performance for latent palm vs. enrolled palm
- Future ELFT evaluations will also evaluate:
 - high-, medium-, and low-resource algorithm performance tradeoffs
 - “reverse latent” (rolled-/plain-print to enrolled latent) matching performance
 - fusion approaches to enhancing performance

For More Information...

Web → <http://fingerprint.nist.gov/latent>

Email → latent-efs@nist.gov

Presentation Overview

1. Introduction to automated latent print ID
2. Automated latent ID technology (AFIS)
3. Latent AFIS technology gaps
4. NIST latent testing & evaluation (ELFT)

Automated Latent Fingerprint Identification Systems (AFIS)

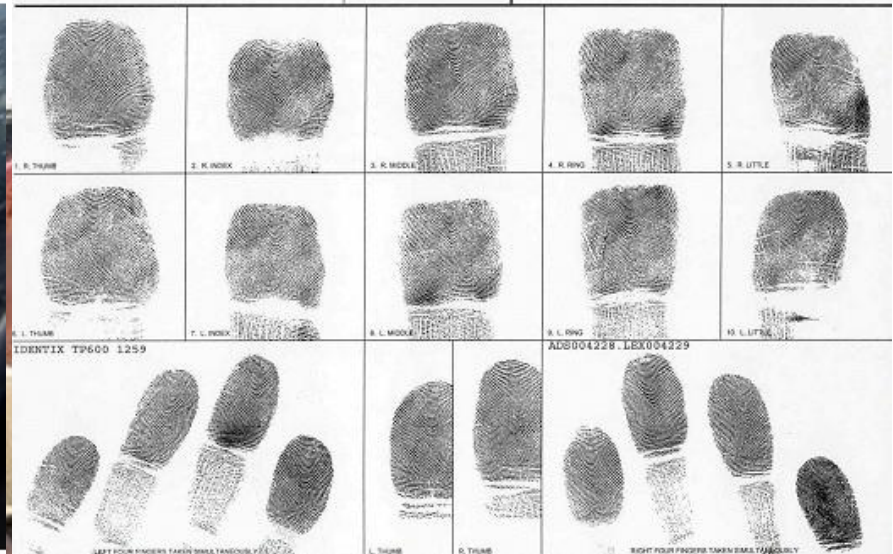
Latent matching unit & database (AKA "AFIS")

Latent workstation



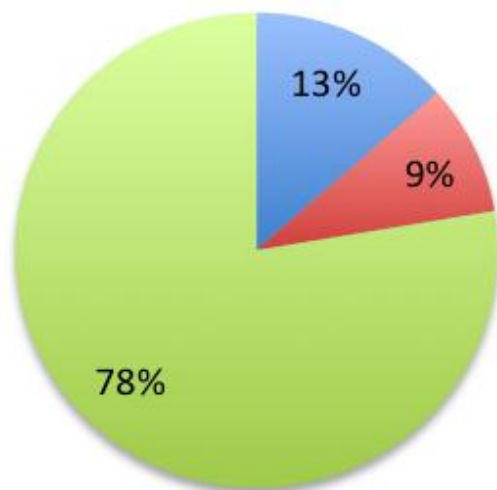
Homeland Security

Law Enforcement & Intelligence



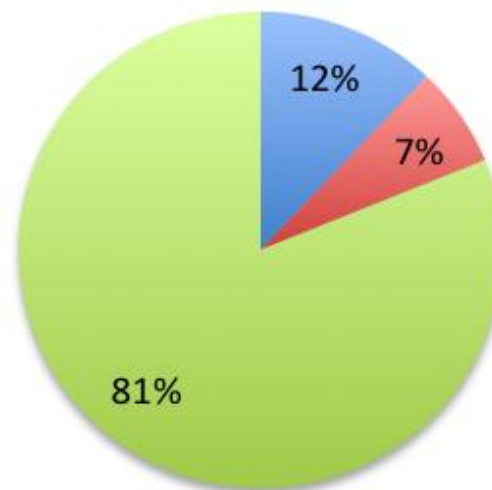
Collective Matcher Performance (1,114 latents)

Evaluation #1

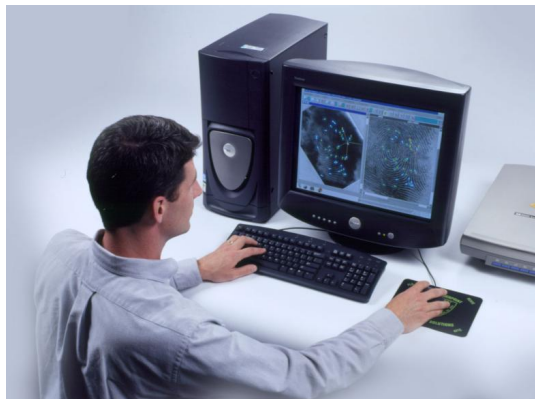


missed by all hit at > r1 hit at r1

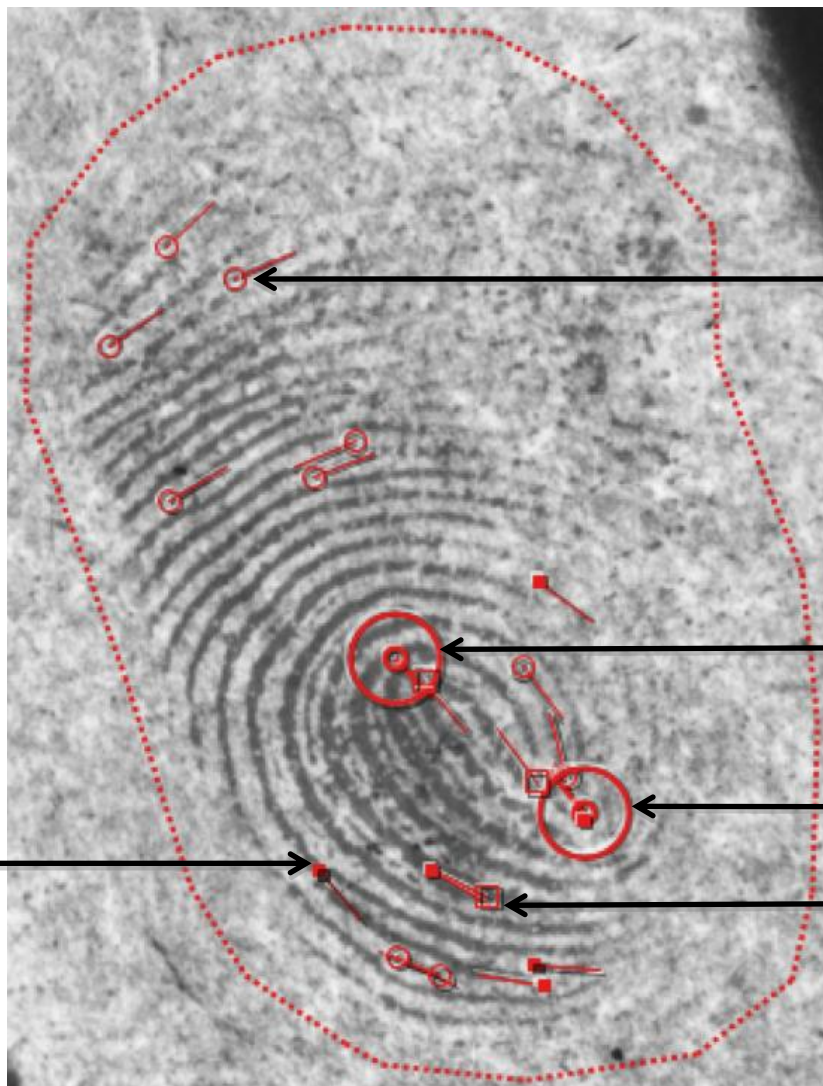
Evaluation #2



missed by all hit at > r1 hit at r1



Latent Examiner



**Ridge
ending**

Core

Core

Bifurcation

Indeterminate

Latent Workstation Screenshot

Roadblocks to Interoperability

- **Lack of cross-jurisdictional interconnectivity**
 - technological differences
 - lack of exchange processes/agreements
 - funding issues, usage policies, legal issues, ...
- **Variation in feature selection, markup, and exchange**
 - best accuracy requires hand-marked features
 - lack of universal standard for data exchange
 - additional AFIS searches = additional examiner workload

Solutions

➤ **Improve AFIS accuracy**

- testing & evaluation to analyze performance/gaps
- standard reference data for developers

➤ **Reduce the need for manual processing**

- determine where “lights out” processing is viable
- improved selectivity (fewer/better candidates)

➤ **Develop interoperable latent search features**

- based on ANSI/NIST-ITL EFS and FBI EBTS (LITS)
- assess accuracy and utility of interoperable features

ELFT-EFS Results: Accuracy vs. Minutiae Count

